Czech ACM Student Chapter

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Connecting the dots

`connect.(c|cpp|py)`, `Connect.(java|kt)`

Qminers operate trading algorithms on many stock exchanges around the world. They want to connect their colocation facilities in all these cities with a single optical network. Since they cannot disclose which cities they actually use, they have decided to connect thousands of cities worldwide instead.

The telecommunications company already has existing network nodes in each of these cities. It is willing to place any number of **additional nodes** at arbitrary locations (that is, outside the original cities). However, it will charge a fee for every kilometer of optical cable used, and for each newly placed node.

Task

Design a network that connects all original cities (i.e., all the cities form a single connected component). Any solution that connects all cities will be accepted by the evaluation system, but only the one with the **lowest total cost** (see below) will be rewarded during the final ceremony.

Input Specification

The first line contains two integers N and S, where:

- N is the number of cities, $N \leq 10000$,
- S is the cost of adding one new node, $0 \leq S \leq 10000$.

The following N lines each contain two integers from the range $[0, 2^{30} - 1]$ — the coordinates of individual cities on the plane.

Output Specification

The first line should contain two integers V and E, where:

- V is the number of added nodes,
- E is the number of connections (edges) between nodes or cities.

Then follow V lines, each containing two integers — the coordinates of added nodes, again within the range $[0, 2^{30} - 1]$. After that, output E lines, each containing a pair of integers "u v", indicating that node u is connected by cable to node v.

Numbering convention:

- Cities are numbered 1 through N in the order they appear in the input.
- Added nodes are numbered $N+1$ through $N+V$ in the order they are listed.

Scoring

The total cost of the solution is the sum of the Euclidean lengths of all cable connections plus the term $S \times V$ for all added nodes. If not all cities are connected into a single connected component, the solution is considered invalid (infinite cost).

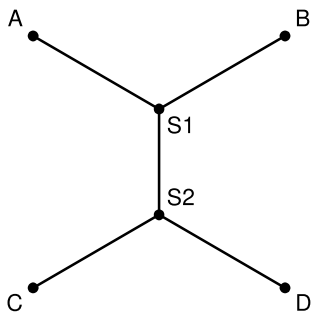
Example

Sample Input 1

```
4 5
0 0
0 100
100 0
100 100
```

Output for Sample Input 1

```
2 5
29 50
71 50
1 5
2 5
3 6
4 6
5 6
```



This solution corresponds to cities A, B, C, D and added nodes S_1, S_2. If the node cost is $S = 5$, the total cost is approximately 283.2. If $S = 10$, a single-node solution would be preferable.
